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Bi-Monthly Progress Report

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(E73-10445) UTILIZATION OF ERTS-1 DATA TO MONITOR AND CLASSIFY EUTROPHICATION OF INLAND LAKES Bimonthly Progress Report, 1 Feb. - 1 Apr. 1973 (Bendix Corp.) 6 p HC $3.00 CSCL 08H G3/13

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Third Type 1 Progress Report
Period 1 February - 1 April 1973

a. TITLE: Utilization of ERTS-1 Data to Monitor and Classify Eutrophication of Inland Lakes. GSFC PR 518, MMC 598, Phillip E. Chase

b. Objectives:

The objectives of the study are to demonstrate the feasibility of ERTS in measuring the state of eutrophication of inland lakes as a broad survey monitor. Specific objectives are:

1. Determine the minimum size of inland lakes detected by ERTS when considering factors of color, size, shape, and shore definition.

2. Determine correlation of surface color to various indices of eutrophication for preparing charts of eutrophication versus surface color. Such indices are algal count, Secchi Disk transparency, leptopel content, macrophyte extent, phosphates, etc.

3. Determine if algal blooms are detectable by ERTS when they occur and color the surface of small inland lakes. Algal blooms are an indicator of enrichment.

4. Determine if changes in leptopel level are detectable by ERTS. This is another measure of eutrophication that can be related to ERTS.

5. Determine the feasibility of establishing classification of levels of inland lake eutrophication by either lake, pond, and swamp taxonomies or by individual indicators such as surface color, transparency, leptopel level, and appearance of algal blooms.

c. There has been no need for receipt of ERTS-1 data gathered during the February and the first 3 weeks of March because of ice. An excellent day for ERTS-1 occurred on March 27* and it is highly desirable that the full set of data be sent as soon as possible. CCT were received for scene 1067 - 15463 and used for processing as described in the 1st semi annual. No new imagery has been requested during the reporting period other than the 27 March (and 28 March which will only be adequate).

*28 March was an adequate day and will be useful as a comparison to scene 1067 - 15463.

d. Accomplishments

1. Two papers were prepared. One paper was prepared and submitted for publication in the ERTS-1 Significant Results at GSFC during the first week of March. The second was a detailed semi-annual which completed most of the first objective of the contract.

2. The final step in completing the first objective is to process the CCT of Scene 1067 - 15463 to demonstrate that bottom reflection in shallow areas can be separated from deep water reflection. This has been accomplished during this reporting period by

   a. Adjusting the digital levels in each band to separate as many types of water masses as possible. The digital printouts of these water bodies after optimum selection of levels indicated that: Bands 6 and 7 have four levels of digital data and are not a single density as appears in the received imagery; Bands 4 and 5 each have at least 4 levels. This is a signficant result.

   b. Four distinct types of lake reflectance were identified in Orchard Lake. Shoreline and shallow water was well correlated between past bathymetry, (1940), past large scale aerial photography (1965) and the ERTS-1 digital printouts. The best agreement was between the aerial photography and ERTS-1 printout in Band 5. The bathymetery comparison was less reliable because of its age, and because light penetration measurements were not made (disappearance of a Seckhi Disc). Bathymetry maps are extrapolated from soundings. Weeds are not usually indicated in bathymetry maps. The cause for the separation into two additional water masses was not known. This occurrence is both highly encouraging and significant. Although there were two digital levels in deep water, only one was arranged such that training sets could be selected. We are down to the limit of resolution of the ERTS-1 system and statistical decision processing will be less successful because of sample size. It might be necessary to resort to probability density imagery to obtain certain types of water masses. This step was accomplished by selecting training

sets from the printouts and obtaining scatter diagrams from cluster analysis. The decision imagery of the 3 types of water and "all other" categories will be prepared probably before receipt of this report. Past experience in obtaining scatter diagrams strongly implies that the imagery will show the 4 types of water reflectance.

3. Field tests and aircraft data gathering were conducted 27 March on five test lakes (Orchard, Cass, Forest, Island, Lower Long) and 28 March on Lake Angelus. March 27 was exceptionally clear (18-20 miles visibility) with a cloudless sky. The following types of data were gathered in approximately the same time frame on 27 March.

   a. RPMI, the full set of water quality data, and Forel-Ule data

   b. While one ground team using the RPMI was on Forest Lake the satellite and the NASA C-130 came over simultaneously. The other team, gathering water quality data and RPMI data, was on Orchard Lake when the aircraft flew over within minutes. The aircraft and satellite data were as closely coordinated as possible. Both aircraft and satellite passed over at approximately the half way point in the surface data gathering period.

      The color measurements of RPMI, C-130 MSDS, C-130 color photography, and ERTS-1 scanner data comprise a large set of data aimed at sensing the spectral characteristics of lake incident light at 3 feet, lake return light just below the surface, just above the surface, at 3 feet, at 3500, 7000, 14000 ft and at satellite altitude. The RPMI and ERTS-1 have the same spectral bands while the MSDS has 24 channels. The Forel-Ule is a subjective technique that is an orderly way for the observor to record his integrated version of the water color.

The type and concentration of algae varied from lake to lake. The fairly complete set of water quality data gathered in conjunction with the complete set color data should, when processed and interpreted, be a major step towards satisfying objectives 2, 3 and 4. Macrophytes had not as yet appeared and additional data must be gathered in the summer and fall. It was in excellent field test if the ERTS-1 and C-130 systems operated properly.

The field test on 28 March was less successful. Only Lake Angelus was measured and water quality data was gathered. There was high Cirrus at satellite passage and it clouded over ten minutes later. RPMI data could not be completed. The C-130 was not scheduled. This satellite data is probably similar in transmission quality to that recorded by ERTS-1 in scene 1067-15463.

4. Activities planned for the next reporting period.

   a. Process and interpret the color and water quality data obtained in the highly successful field test of 27 March. Determine if objectives 2, 3, 4 are satisfied in the comparison of the test lakes.

   b. Intensive water quality data gathering of one or two lakes will be conducted for the next cloud free (over test site) overflight. The purpose is to determine how patchy the algae concentration is and whether it can be detected in the ERTS-1 data.

   c. Process and interpret the 28 March ERTS-1 and water quality data of Lake Angleus appeared to be having an algae bloom.

e. There were several significant results.

1. Bands 6 and 7 have fine structure as obtained by proper selection of digital levels in processing the CCT's. This is contrary to the imagery density received. This means that the small lakes can be classified in IR for different types of water masses.

2. At least four distinct water masses have been determined for test lakes. They are shoreline, shallow water, and two deep water. One deep water is patchy and presents difficulty in training set selection.

3. The excellent weather and a completely successful field test form a significant happening. It required 12 orbits over the test area before perfect weather occurred.

f. No release of information or requests for permission to release information have been made during the reporting period.

g. No changes in operation procedure required.

h. A standing order change dated 12 October 1972 requested acceptable cloud cover be 60% instead of 40%.

i. None have been submitted because of excessive cover. One will be submitted for 27 March when it is received.

j. No retrospective orders have been submitted for the test area.

k. Work to date conforms to schedule (Item in paragraph 3.1 of Spec. 5-250-P-1C).